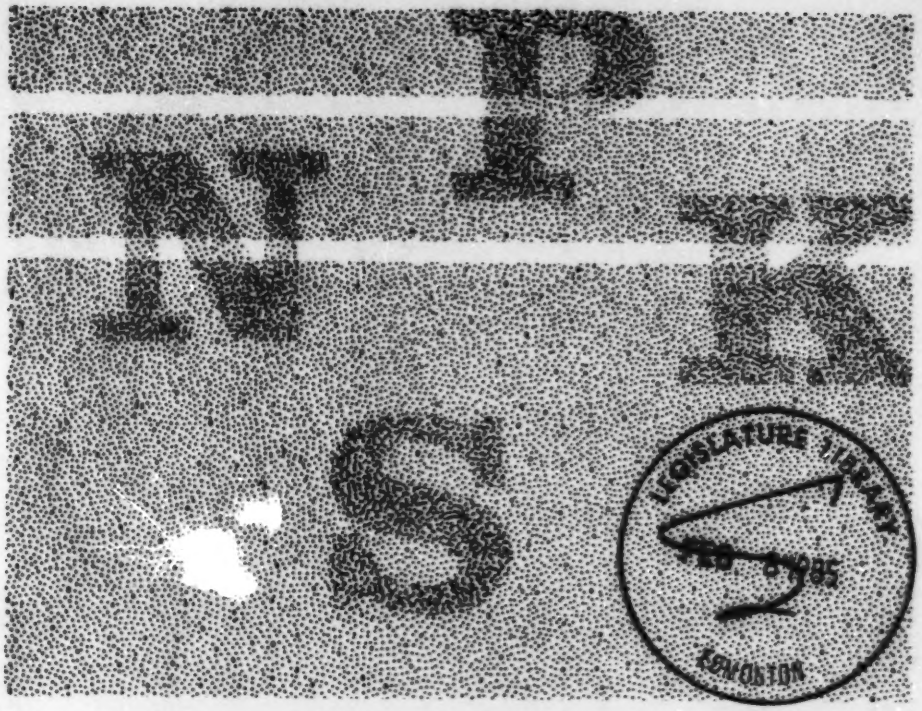

fertilizer application equipment

Alberta AGRICULTURE

AGDEX 542-6

Soils Branch

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fertilizer application equipment

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FERTILIZER APPLICATION EQUIPMENT

INTRODUCTION

The number of methods used to apply fertilizer has increased in recent years. Many standbys remain commonplace throughout Alberta, however, several new methods are being considered by farmers wishing to improve the effectiveness of their fertilizer applications and to improve the efficiency of their field operations. There are three forms of fertilizers:

- granular (dry)
- solution (liquid)
- gaseous.

Fertilizer application equipment fits into five major categories:

- Broadcast - spreads the fertilizer evenly over the soil surface.
- Seed placed or side-banded - places the fertilizer with the seed or in a band near the seed or growing plant.
- Deep band - places the fertilizer in distinct and compact rows below the soil surface prior to seeding.
- Fertigation - applies the fertilizer through irrigation systems.
- Foliar application - sprays the fertilizer onto growing plants.

BROADCAST APPLICATORS

Granular or Dry Fertilizer

When the limits for seed-row placement are to be exceeded, the fertilizer must be applied in other ways: the most common is to broadcast the fertilizer on the surface and incorporate it with a tillage operation.

The single and double spinner spreaders are popular despite the fact that the typical application rates may vary by up to 15 per cent. Overlapping the rows by 10 per cent and positioning the double spinner blades away from the direction of rotation can reduce the variation to an acceptable 10 per cent. Some machines with a similar hopper and axle arrangement use an airflow distribution system rather than spinning discs. Performance is about equal.

Dribble spreaders use a full width fertilizer box and metering system (similar to, but larger than, the granular herbicide applicators). Variations in application are usually less than 10 per cent. The units may be mounted on a trailer, truck, floater or cultivator in which case incorporation is completed in the same operation. Examples are shown in Figures 1 and 2.

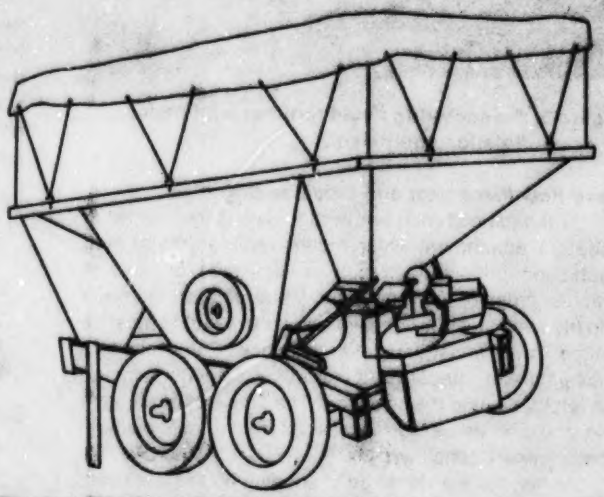

Figure 1. Tractor pulled spinner spreader.

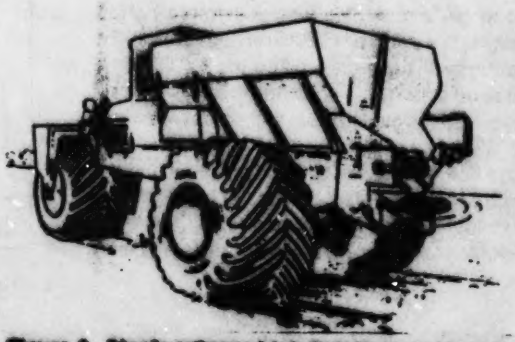

Figure 2. Single spinner high flotation equipment.

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Liquid Fertilizer

Field sprayers equipped with stainless steel or polyethylene tanks with corrosion resistant components may be used to spray liquids or solutions containing nitrogen, phosphorus and potassium on the soil surface prior to incorporation by tillage. Some soil incorporated herbicides may be added to the tank as well. Several custom operators offer this service in Alberta. They also have the equipment for transporting solution fertilizers. An example of equipment used to broadcast liquid fertilizer is shown in Figure 3.

Figure 3. Broadcasting liquid fertilizer with high flotation equipment.

Seed Row Placement and Side Banding

The most common and well known is the planter or seed drill attachment which meters fertilizer into or near each seed row. Although most are designed for use with granular types of fertilizer, some meter solution fertilizers into the seed row. Nitrogen and phosphorus rates must be limited to prevent germination damage. Some seeders such as disker-seeders and cultivator-air seeders spread the fertilizer within the seed row. The amounts of nitrogen and phosphorus can be increased a little, especially in good moisture conditions.

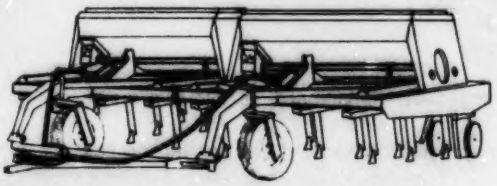
As there is a wide range of seeding equipment used, the concentration of fertilizer in the seed row varies with equipment.

Standard single and double disc drills cut a narrow furrow and place the seed and fertilizer together in the bottom of the furrow. These drills place the fertilizer in a concentrated band close to the seed and are most likely to result in damage to sensitive crops at high rates of fertilizer application.

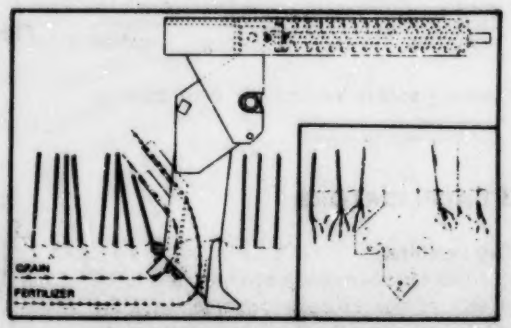
Disker and hoe type drills cut a wider furrow and the seed and fertilizer are scattered across the bottom of the furrow. This scattering in a wide band results in a lower concentration of fertilizer close to the seed and is less likely to cause damage to sensitive crops when moderate rates of fertilizer are applied.

Drills with separate fertilizer banding attachments place the seed and fertilizer in separate furrows and are least likely to cause damage to sensitive crops when high rates of fertilizer are applied.

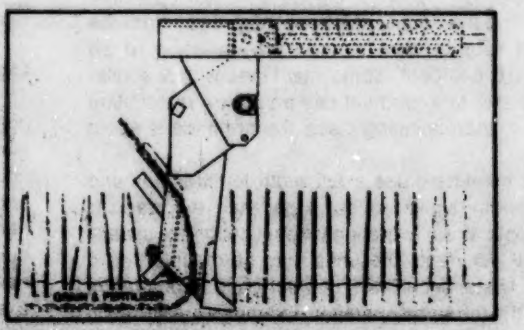
Side-banding refers to placement of a fertilizer band in some exact and consistent geometric relationship to the seed row. It may be either directly below, or below and to the side any distance up to half way to the next seed row. Some of the new no-till grain drills can side-band fertilizer. Many row-crop seeders also have the ability to side-band fertlizer. Tests of other fertilizer openers and split seed-fertilizer openers continue. New equipment is being developed that can side-band fertilizer at the time of seeding. Several types of drills used for seed-row placed and side-banded placed fertilizer are shown in Figures 4, 5, and 6.



5a. Hoe drill.



5b. Fertilizer placed with the seed using a hoe drill.



5c. Fertilizer side banded using a hoe drill.

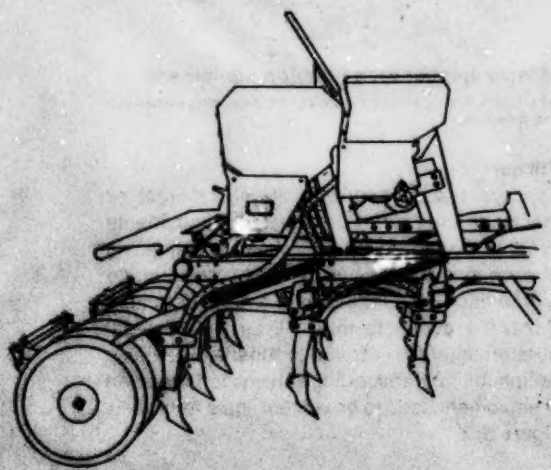


Figure 4. Typical hoe drill used for placing fertilizer in the seed row.

Figure 6. Typical hoe drill used for stubbling in and fertilizer application.

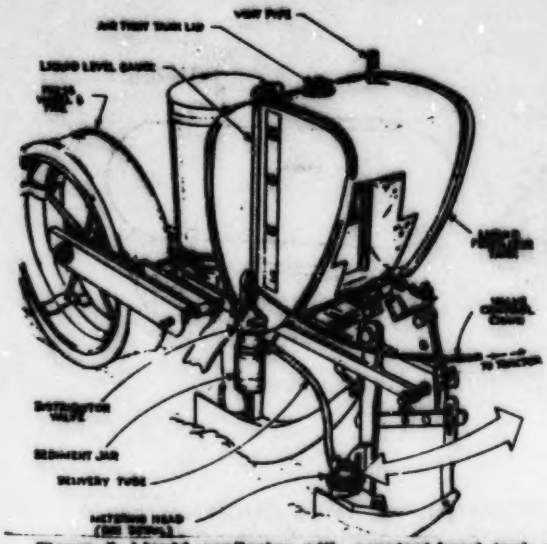


Figure 6. Liquid applicator with constant-head tank and orifice plates.

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DEEP BANDING APPLICATORS

Anhydrous Ammonia (NH_3)

Although the term "deep banding" is new, it describes exactly what anhydrous ammonia applicators have been doing for years. Anhydrous ammonia (NH_3) is handled in a liquid form and must be kept under pressure. The applicator forms bands of NH_3 10 to 15 cm (4 to 6 inches) deep in the soil, and usually spaced 30 to 40 cm (12 to 16 inches) apart. As the NH_3 leaves the tank it is liquid, but in the piping it begins to change to gas (NH_3 boils at -33°C, water boils at 100°C). When the NH_3 reaches the soil it is about 50-50 gas and liquid, but the rest of the liquid rapidly changes to gas and forms the nitrogen band. The operation is most successful where the soil is in a good workable condition, generally following a tillage operation.

Some modifications to the NH_3 applicator could eliminate pre-application tillage under many conditions. A heavy duty spring shank and a narrow knife opener, 1 to 2 cm (½ to ¾ inches) wide, may be substituted for the standard shank allowing deeper penetration in untilled soils. In very moist soil, take care to see that the opening closes behind the knife to seal in the NH_3 gas. Another alternative is a chisel plow (heavy duty cultivator) equipped with an NH_3 nurse tank, similar narrow knife openers and necessary metering valves, distributors and hoses. Rather than a narrow knife alone, a modified knife may be attached behind and below a regular cultivator sweep. Tillage and NH_3 application may be done in one operation. Tine harrows mounted on the cultivator will help seal in the NH_3 gas and help prevent soil moisture loss if applied in the spring.

The recent introduction of "Cold-flo" (registered trade mark of United States Steel Agri-Chemicals) reduces the loss of NH_3 gas when applied at shallow depths as with a chisel plow equipped with sweeps. The converter(s) reduce the pressure on the NH_3 to near atmospheric pressure allowing only 15 percent of the NH_3 to vaporize (change from liquid to gas). The heat required for this amount of NH_3 to vaporize comes from the remaining liquid and causes the temperature of the liquid to drop below its boiling point (-33°C). Both the gas and cooled liquid are injected into the soil. The depth of injection may be reduced to 7-10 cm (3-4 inches), as the cooled liquid does not change to gas until it warms up allowing it more time to react and be bound to the soil.

There are two other benefits of the Cold-flo system. The ammonia expansion takes place in the ammonia converter instead of at the shank tip; this moves the refrigeration process from the shank to the converter. This

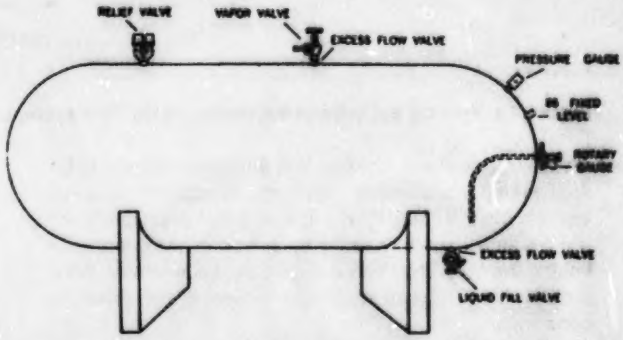


Figure 7. Schematic drawing of a storage tank with valves and fittings. Most storage tanks are also equipped with temperature gauges. The exact location of the valves and fittings will vary from tank to tank.

Reproduced from Agricultural Anhydrous Ammonia Technology and Use, 1966, page 145 by permission of American Society of Agronomy and Soil Science Society of America.

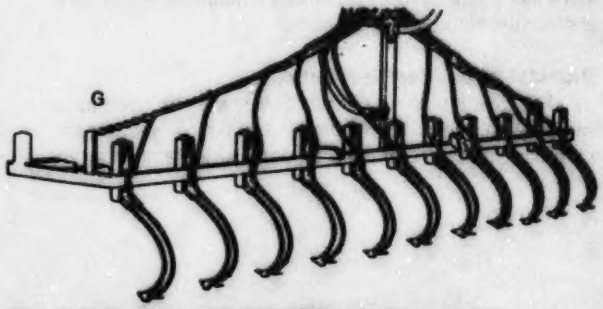


Figure 8. Typical cultivator with anhydrous tubes.

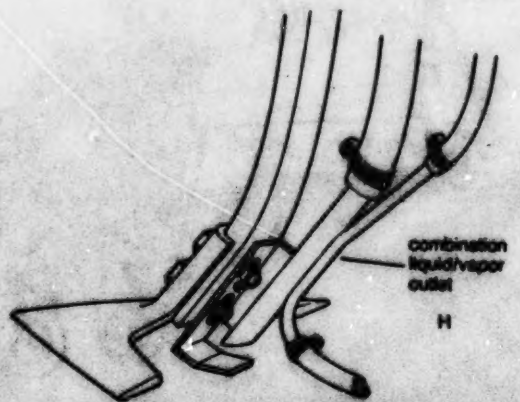


Figure 9. Typical ammonia and liquid fertilizer outlets at the back of a cultivator shank.

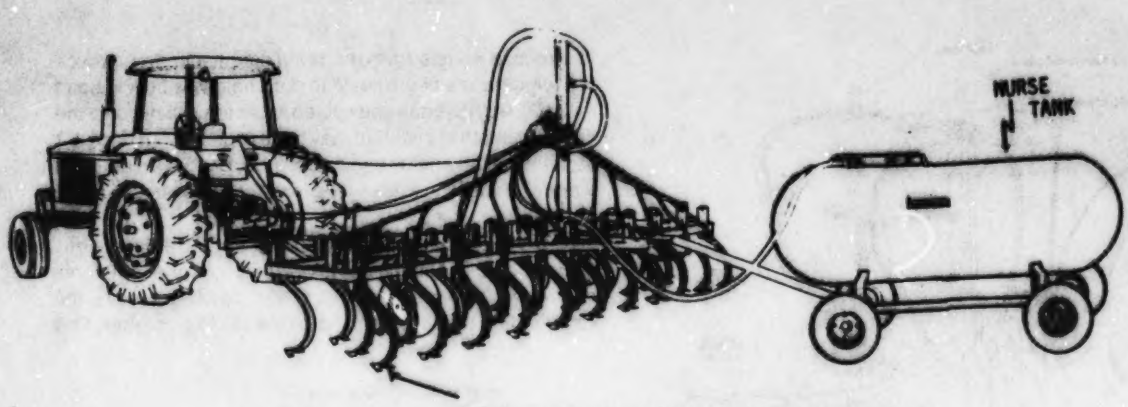


Figure 10. Typical anhydrous ammonia - cold flow system.

results in less shank freezing and enables ammonia to be applied under cooler soil conditions. In addition, because ammonia is in a liquid form under very little pressure, there is more time for better sealing by using harrows or packers behind the cultivator. This makes Cold-flo ammonia more suitable for applications under adverse soil moisture conditions.

There are two types of ammonia converters. A small mini converter may be attached to up to four shanks, or one large converter with one or more distributors may serve the whole machine. After the NH_3 passes through the converter it flows only by gravity, so on machines of more than 10.5 m (35 feet), or in hilly land, the mini converters may provide more even application. Anhydrous ammonium equipment is shown in Figures 7, 8, 9 and 10.

Granular or Dry Fertilizer Banding

The chisel plow or field cultivator may be used as a base for a pneumatic (airflow) distribution attachment which can band one or more dry fertilizers. Bands may be placed 7 to 15 cm (3 to 6 inches) into the soil and spaced 20 to 30 cm (8 to 12 inches) apart depending on the particular cultivator used. An airflow machine is now available which is intended solely for fertilizer banding. It offers a simpler attachment to the cultivator. The air lines, distributors and shank mounted outlets may be permanently installed on the cultivator. The hopper, undercarriage, fan and metering systems are attached when applying fertilizer.

The outlets of most cultivator-air seeders are designed to spread the seed row into a 7 to 12 cm (3 to 5 inch) wide band. As it is desirable to apply fertilizer in a narrow band, the deflectors should be removed or the opener modified so fertilizer will fall to the centre and deepest part of the furrow. Delivery rates of dry fertilizer banding machines range up to 250 pounds per acre. The maximum rate depends on the fertilizer type, field speed and individual manufacturer.

Hoe drills, or heavy duty double disc drills, with or without coulters may be used to directly bury narrow spaced fertilizer bands. Although this is a form of banding,

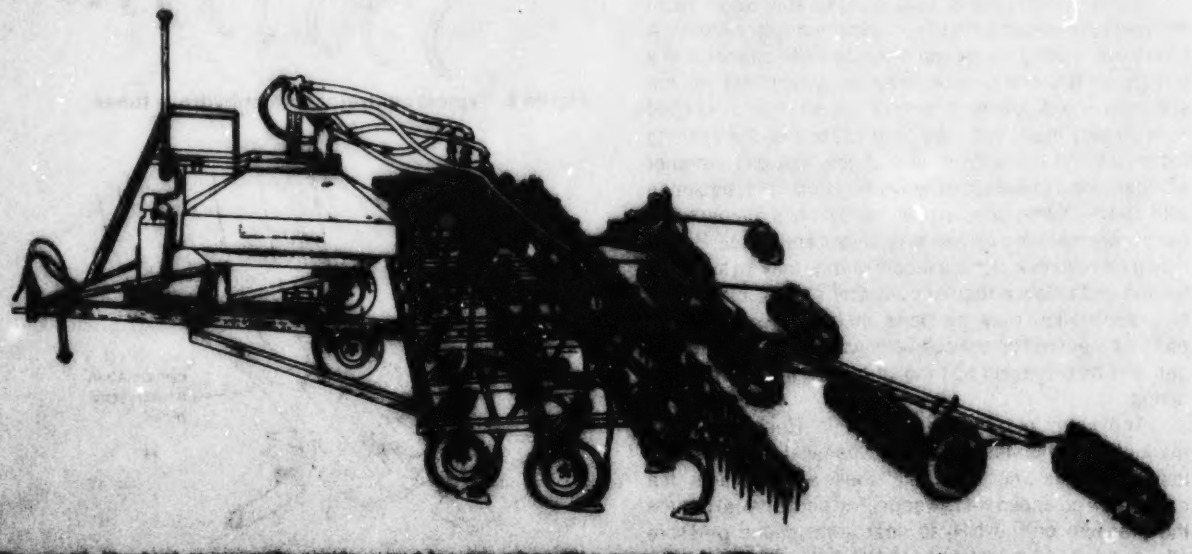
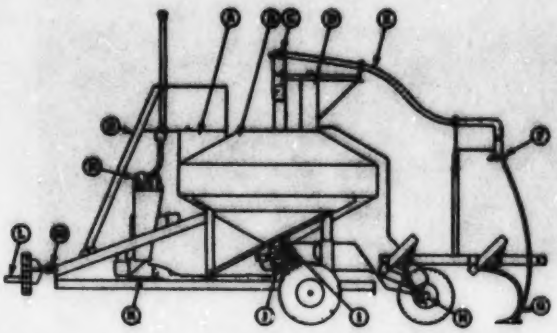


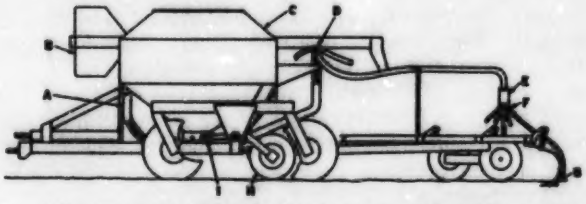
Figure 11. Typical pneumatic cultivator used for dry banding granular fertilizer.

the advantage of the high concentration of fertilizer may be lost with this method compared with 30 cm (12 inch) spaced bands. However, the method is considerably better than broadcasting in minimum tillage conditions. Equipment used to deep band granular fertilizer is shown in Figures 11, 12, 13, and 14.



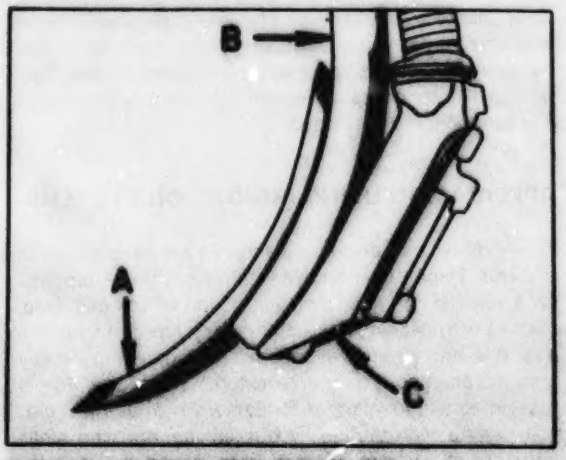
A) Fuel Tank B) Tank C) Primary Header D) Hydraulic Oil Reservoir E) Primary Hose F) Secondary Header G) Seed Boot H) Meter Drive I) Tank Agitator J) Metering System K) Fan L) Cultivator Hitch M) Applicator Hitch N) Fan Engine O) Ladder

Figure 12. Diagram of one Friggstand type of air seeder used for deep banding fertilizer.



A) Fan B) Loading Auger C) Tanks D) Primary Header Valves E) Electronic Monitoring System F) Secondary Header G) Seed Booth H) Meter Drive Wheel I) Metering System.

Figure 13. John Deere 685 Central Metering Seeder.



A) Chisel Point B) Cultivator Shank C) Banding Boot.

Figure 14. Fertilizer banding boot used on air seeder.

Solution Fertilizers

A chisel plow or field cultivator may also be used to band solutions like 28-0-0, 10-34-0, 4-10-10, or any blend as required. The equipment required includes nurse tanks, trailing or tractor mounted, a solution pump, metering and distributor valves, hoses and shank-mounted outlets. The bands may be placed from 7 to 15 cm (3 to 6 inches) deep and are usually spaced 30 cm (12 inches) apart. The fertilizer can be applied during normal fall or spring tillage. Since the fertilizer solution is pumped under pressure to the distributor, there is even application across the full width of the implement. Calibration of the system is maintained by a variable ground driven pump.

Very high field efficiency can be obtained with solutions and dry fertilizer banding methods. Other operations such as trash covering, weed control and herbicide incorporation may be combined with the fertilizer application (note: application of soil incorporated herbicides should follow the fertilizer banding operation). A second tillage operation for incorporation of the herbicide should be delayed to avoid disturbing the fertilizer band. Performing the operations in this order will leave the herbicide at the right depth and uniformly distributed. Equipment used to deep band liquid fertilizer is shown in Figures 15, 16, 17 and 18.

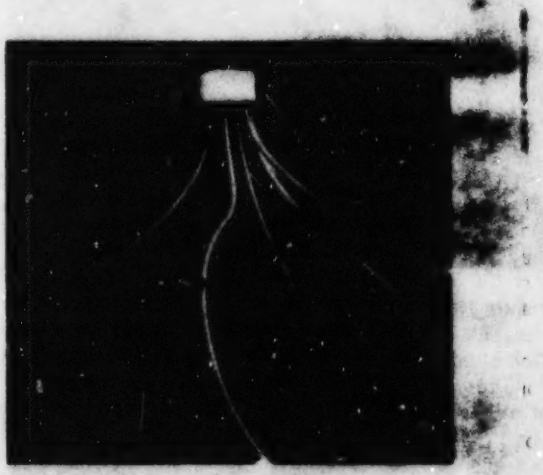


Figure 15. Liquid fertilizer splitter.

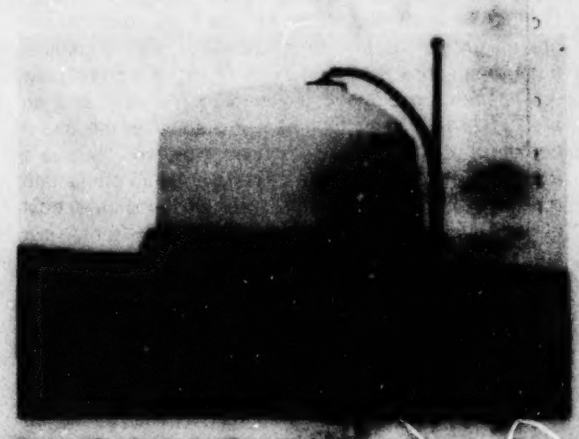


Figure 16. Liquid fertilizer tank.

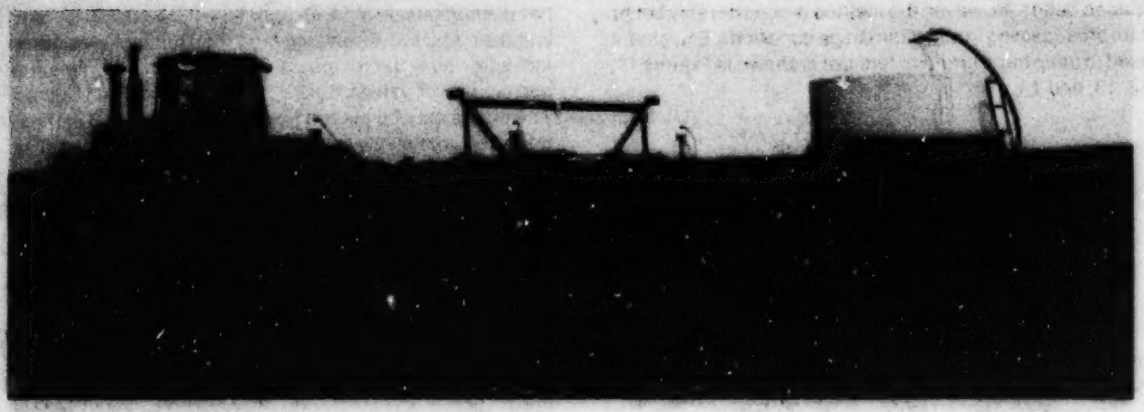


Figure 17. Liquid fertilizer deep banding applicator.

Figure 18. High floating liquid banding system.

Combination (Two Type) Fertilizer Banding

In order to utilize the lowest cost, most readily available, or easiest to handle form of nitrogen and phosphorus, some machines are being assembled to "double shoot" two different fertilizer types (i.e. granular phosphate with anhydrous ammonia). A basic chisel plow or standard NH_3 applicator is equipped with two separate fertilizer systems for either NH_3 and solutions, NH_3 and granules, two types of granules or two types of liquids. The likely combinations are an anhydrous ammonia applicator with a solution fertilizer attachment for liquid phosphate, or a chisel plow equipped for pneumatic dry fertilizer delivery and an anhydrous ammonia attachment. In both cases the lowest cost form of nitrogen, NH_3, is used. However, there is a trade-off between the more expensive liquid phosphate over less expensive dry forms, considering the lower cost of liquid application equipment. Also, liquid phosphate is a lower analysis product than the dry form and therefore requires almost twice as much handling. The air flow system offers the advantage of using low cost, higher analysis granular phosphate, and the second most economic nitrogen form, urea. Air flow systems can also be used with anhydrous ammonia equipment to apply simultaneously. This also uses the least expensive nitrogen source, anhydrous ammonia, with the least expensive phosphorus source, granular mono-ammonium phosphate.

There is little interference when the dual fertilizer systems are installed on one machine with one minor exception. The heat absorbed at the outlet by the expanding NH_3 (liquid to gas), whether hot or Cold-flo, can cause freezing of the lines and a build-up of soil. This frozen soil may block the outlet of the liquid or granular spouts. Cold-flo ammonia causes less freezing of the lines because the refrigeration process has been moved up to the converter. To avoid this situation the liquid or granular outlet must be separated from the NH_3 tip by at least 10 cm (4 inch), more if the plugging persists. The NH_3 tip is located closest to the tip of the knife or shovel to ensure deep placement and good soil cover. The second tip should be as deep to maintain a compact band; but trail behind by the required separation distance.

Combination equipment requires more power, therefore, the solution fertilizer tanks could be mounted on the tractor to provide the extra traction needed.

All the components needed for fertilizer banding are available. It is up to the farmer or custom applicator to install the parts on an acceptable cultivator or NH_3 machine. Many fertilizer distributors have the expensive components of the system (pneumatic delivery, NH_3 or solution nurse tanks) for rent. The farmer must then install his own distributor, hoses and ground openers. See Agri-fax 825-14 *Economics of Alternative Methods of Anhydrous Ammonia Application* - 1983.

APPLICATION USING IRRIGATION SYSTEMS

Fertilizer can be applied through sprinkler irrigation systems. This process is called fertigation. Its use depends on a number of factors including type of soil and crop, method of irrigation used, water quality, types of fertilizers available and general economics. Fertigation is usually most advantageous on coarse textured, sandy soils. This is most important for nitrogen fertilizers. On coarse-textured soils with a high probability of leaching, applying small amounts of nitrogen several times during the growing season can give economic yield increases. On fine-textured soils, where leaching of nutrients is very low and one basic application of fertilizer is adequate for the entire growing season, fertigation may not have an advantage

over other methods of application.

Sprinkler irrigation systems such as handmove, wheelmove and centre pivot sprinkler systems give a more or less uniform water and fertilizer distribution over the field. With gravity irrigation systems such as border dyke, border ditch and furrow systems the water distribution of the field is often uneven and therefore fertigation may result in uneven fertilizer distribution. Generally, fertigation is only recommended with sprinkler irrigation systems in Alberta.

The techniques of fertilizer injection into an irrigation system are covered in Agdex 753-2 *Chemical Injection in Irrigation Systems*.

The most common method of introducing fertilizer into an irrigation system is to use a small pump to inject or force a solution from the supply tank into the irrigation stream. The injection pump must be operated at a pressure higher than the irrigation pump used to pressurize the pipeline. The most common injection pumps are positive displacement piston pumps.

The kind of fertilizer to be used in fertigation has to be chosen very carefully. In many cases, because of water quality, the application of solutions containing free ammonium (anhydrous ammonia) is not too practical. Urea (46-0-0) and ammonium nitrate (34-0-0) are suitable for use in fertigation, in practically all conditions. Ammonium sulfate (21-0-0-24S) may produce an acid reaction in the water and may be corrosive to irrigation equipment. Generally, the liquid nitrogen fertilizer 28-0-0 is most commonly used in fertigation.

Phosphate fertilizers in their conventional form such as superphosphate cannot be used in fertigation because of their low solubility; in addition soluble phosphate precipitates and causes clogging. Generally, the liquid fertilizer 10-34-0 is most commonly used for applying phosphorus through the irrigation system. There is no advantage in applying phosphorus through the irrigation system, it may even be a less effective method of applying phosphorus than seed placed or deep banded applications.

Applying postassium in irrigation water is relatively free of problems owing to the high solubility of potassium salts, although it is rarely required in irrigated areas of southern Alberta.

Micronutrients can be added by fertigation as well. The same principles must be used as with other fertilizers. Solubilities and compatibilities with irrigation water must be considered. Micronutrient fertilizers are rarely required in irrigated areas of southern Alberta, with the exception of some special crops such as field beans.

FOLIAR APPLICATION

Foliar fertilization is a method of applying fertilizers by spraying the leaves of plants to allow nutrient uptake through the leaves. Foliar application is practised whenever nutrient uptake through the plant roots is restricted. Attempts to supply the major nutrient requirements by foliar application are usually not successful because of the high rates and need for repeated applications which cause foliage scorching. It is also quite expensive. Spraying micronutrients on foliage is practised on specialty crops in some areas of the U.S.A.

A major consideration in selecting fertilizers is the effect of the salt solution on leaves. When the fertilizer salt solution is stronger than the sap in the plant tissue, water will be drawn from the leaf tissue and scorching damage will appear. The pH of solutions to be used as foliar sprays should be near neutral.

CONCLUSIONS

There are many types of fertilizers and methods of handling and applying these fertilizers. This publication covers most of the major fertilizer types and the more common methods of application

For further information on the application of fertilizers, farmers are advised to contact their fertilizer distributor and their local district agriculturist.

Information regarding fertilizer application equipment can also be directed to:

FARM MACHINERY ENGINEER — Airdire 948-5101
SOIL FERTILITY SPECIALIST — Edmonton 427-5346
SOIL FERTILITY SPECIALIST — Lethbridge 329-5126
381-5126 after April 22, 1985

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Farm Machinery Engineer
Engineering and Rural Services
Airdire

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Figures 3 and 18 are used courtesy of Solutions: Journal of The Fluid Fertilizer Industry, Sept/Oct 1982. 8823 N. Industrial Rd. Peoria, Ill. 616515.
Figures 5b) and c) are used courtesy of Haybuster Mfg. Inc., P.O.B. 1950, Jamestown, N.D. 58401.
Figures 8, 9 and 10 are used courtesy of Esso Petroleum Canada.
Figures 12 and 13 are taken from PAMI reports No. E1660A and 270 respectively.
Figures 15, 16 and 17 are used courtesy of Green Drop Ltd., Calgary.

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